





Outline of the Lawrence Berkeley National Laboratory Accelerator Facilities and Capabilities Outreach Event

- Introduction to the DOE OHEP Accelerator Stewardship Test Facility Pilot Program [Dr. Eric Colby, DOE Program Manager]
- The Accelerator Technology and Applied Physics Division of LBNL [Soren Prestemon]
- A synopsis of critical R&D facilities, capabilities, and expertise in accelerator technologies at LBNL

[Soren Prestemon, Thomas Schenkel, John Byrd, Csaba Toth]

- Working with LBNL: the Innovation and Partnerships Office [Betsy Quayle]
- Discussion Questions and Answers





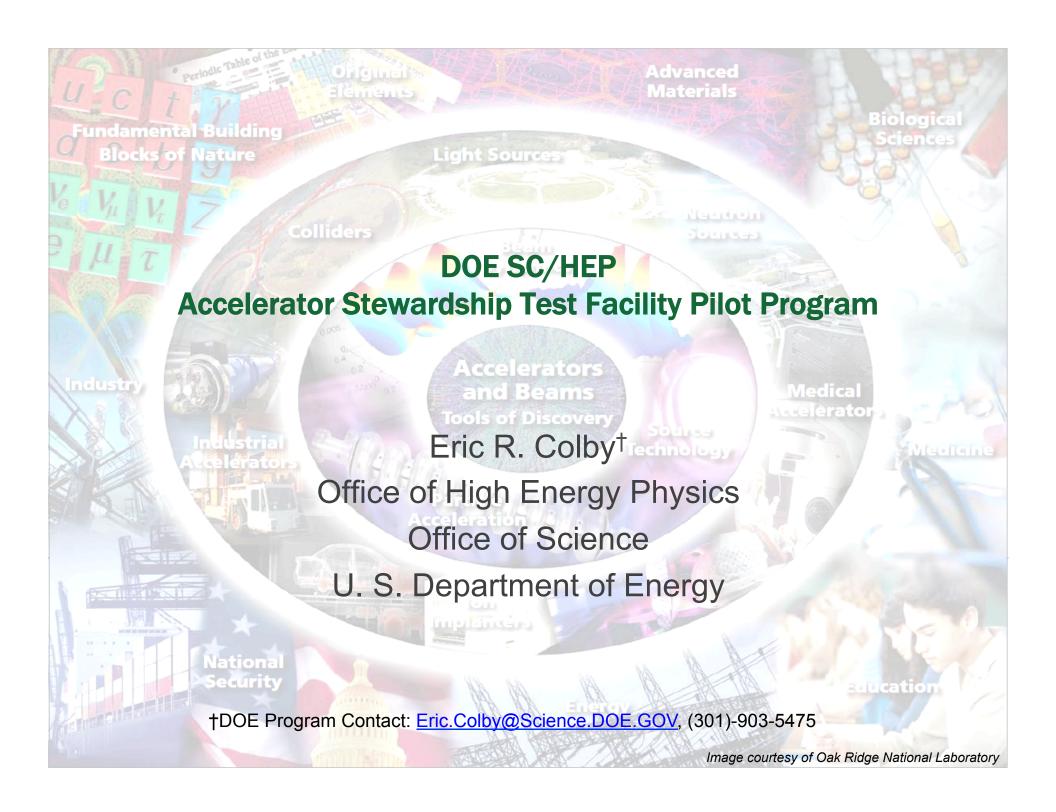


Some comments for todays Webinar...

- Please mute your phone/computer
- Use the "Chat" area to type in questions, or email questions to <u>SOPrestemon@lbl.gov</u>
- This is a first Outreach, designed to provide general information on the type of facilities and expertise that resides in accelerator technologies at LBNL.
- We encourage you to contact as directly later, at your convenience, to explore possibilities in more detail, and perhaps visit our site.







DOE Office of Science Accelerator R&D Capabilities





DOE Office of Science Accelerator R&D Capabilities

- Many unique accelerator R&D capabilities have been developed to support the scientific research of the Office of Science:
 - Design
 - Beam physics and high-performance computing expertise
 - High accuracy modeling of complex accelerator systems
 - Design and engineering of accelerator components
 - Complete concept-to-prototype design capability
 - Fabrication & Subcomponent Testing
 - Superconducting cable/strand and cavity preparation and testing facilities
 - Processing and testing infrastructure for cable and RF cavities
 - Magnet test facilities
 - Power supplies, cryogenic test stands, high precision field mapping
 - Microwave and laser test facilities
 - Microwave and laser source & measurement capability covering a very wide spectrum
 - Fabrication and materials characterization facilities
 - Beam Testing Facilities
 - Provide electrons, neutrons, protons, light and heavy ions, x-rays, gamma rays, ...
 - And more!









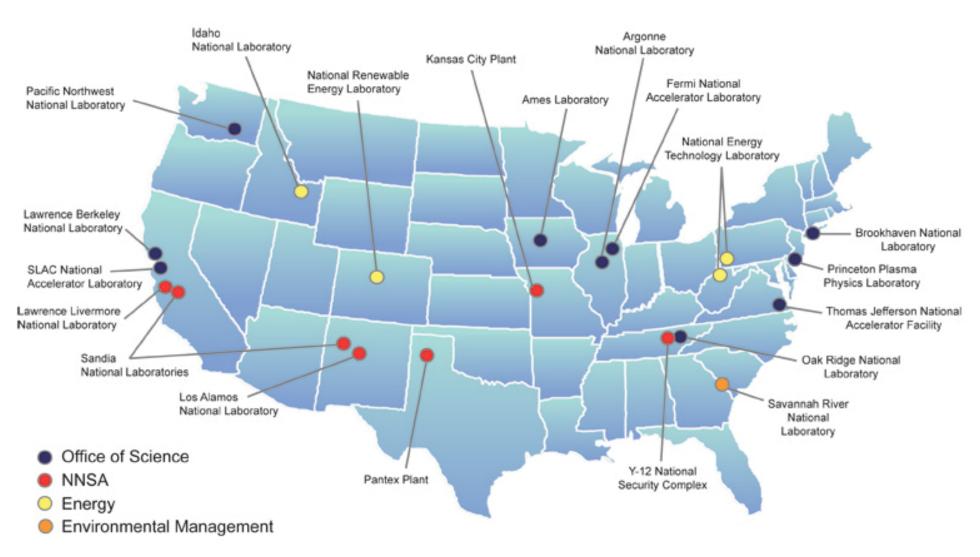






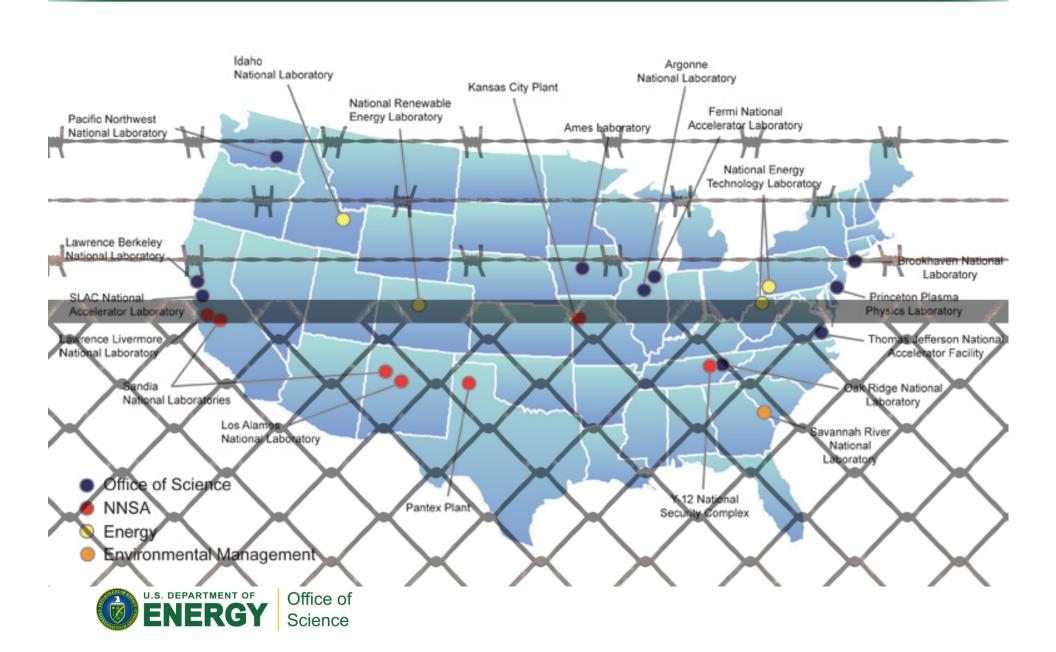


I his is how DOE National Laboratories see themselves...





...and this is how industry has viewed us.



The Accelerator Stewardship Test Facility Pilot Program

Is a one-year Pilot Program to:

- Broaden public awareness of accelerator R&D capabilities at the DOE National Laboratories
- Survey the potential Stewardship demand for accelerator R&D capabilities
- Seed fund a few collaborative R&D efforts
- Test the process and logistics involved in engaging Stewardship users

What activities are potentially eligible for the seed funding?

High-value-added collaborative accelerator R&D opportunities that:

- Mutually benefit the lab and the Stewardship partner
- Capitalize on existing lab accelerator test facilities and expertise

"The proposed work—

- (1) is consistent with or complementary to missions of DOE/NNSA and the facility to which the work is to be assigned,
- (2) will not adversely impact programs assigned to the facility,
- (3) will not place the facility in direct competition with the domestic private sector, and
- (4) will not create a detrimental future burden on DOE/NNSA resources." -- DOE O 481.1C, section 4(c)



Pilot Program Process and Timeline

- April/May Labs conduct public outreach events
 - BNL done!
 - ANL & FNAL April 28
 - JLAB May 4
 - LBNL coming soon
 - ORNL coming soon
 - SLAC coming soon
- June 15, 2015 Labs submit proposals for seed funding
- June/July Proposals are peer reviewed
- Aug/Sept Seed funding to labs
- Spring 2016 Evaluate results of pilot program

National Laboratory Public Outreach Events

The goals of today's public outreach events are:

- Broaden public awareness about the lab's accelerator test facilities and accelerator expertise, and
- Meet potential Stewardship partners, and discuss their needs:
 - What facilities and expertise are needed?
 - What time and effort is needed?
 - What supporting engineering is needed?
 - How will results be published and/or protected?

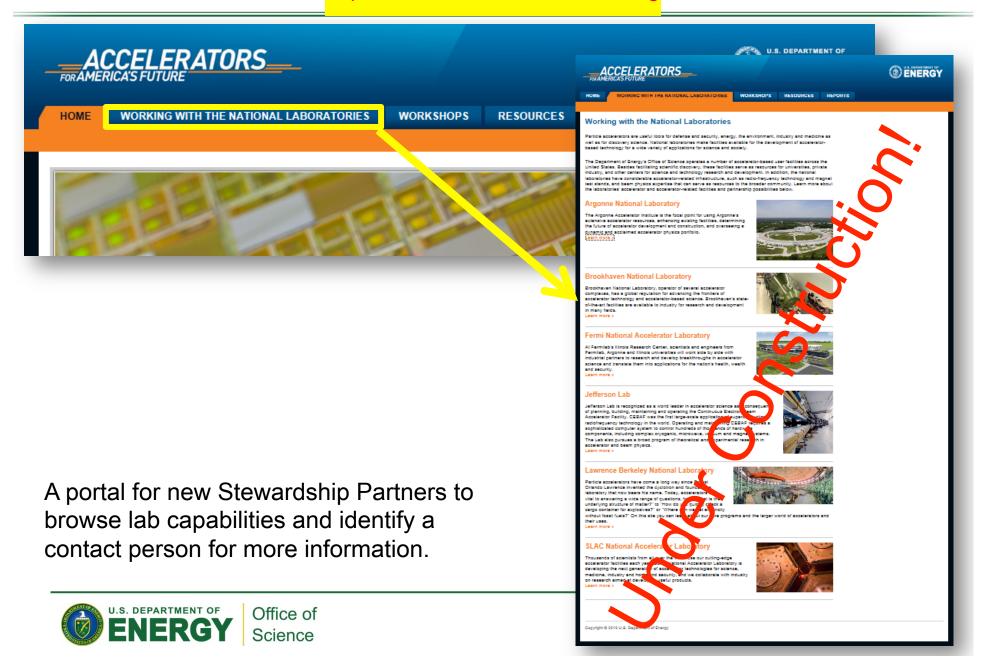
Desired outcomes of the public outreach events are:

- Develop a list of potential collaborative accelerator R&D opportunities
- Propose some of these opportunities for seed funding through the Pilot Program

The stop shopping for infanty / toolorater i top supublition at the

DOE Office of Science National Laboratories

http://www.acceleratorsamerica.org



Additional Information Resources

- The HEP Accelerator Stewardship program is described at:
 - http://science.energy.gov/hep/research/accelerator-rd-stewardship/
- The HEP Accelerator Stewardship program is developing the Accelerator for America's Future website to serve as a portal specific to accelerator R&D test facilities:
 - http://www.acceleratorsamerica.org/working-with-labs/index.html
- More generally, the DOE Office of Technology Transitions maintains:
 - "How-to" guides for interacting with the labs:
 - http://technologytransfer.energy.gov/
 - A general "Portal" for Business to find DOE Labs facilities:
 - http://www.energy.gov/technologytransitions/who-do-i-contact-labs
 - A detailed list of facilities:
 - http://www.energy.gov/technologytransitions/technology-transitions-facilities-database







Lawrence Berkeley National Laboratory has a strong legacy of accelerator technology development

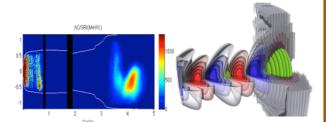


. O. Lawrence 1st cyclotron



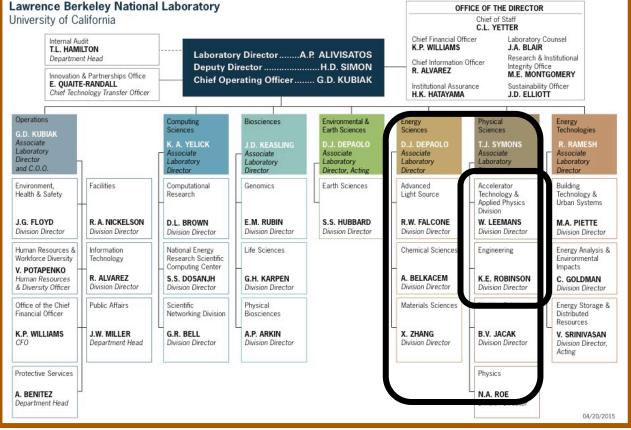
Bevatron

PET scanner



LPA-beam and modeling

Ernest O. Lawrence founded the "Radiation Laboratory" in 1931, launch the modern era of multi-disciplinary national laboratories See http://history.lbl.gov for an overview of LBNL legacy in accelerators and science









Accelerator Technology & Applied Physics Division Organization Structure

Wim Leemans

Division Director

Soren Prestemon **Division Deputy, Technology**

Asmita Patel Division Deputy, Operations

Eric Esarey Senior

Scientific Advisor

ALS Accelerator **Physics**

Center for Beam Physics **Fusion Science** Ion Beam Tech

Superconducting Magnets

LOASIS / BELLA

Special Projects

David Robin. Head Tom Scarvie. **Deputy**

John Byrd. Head Derun Li. **Deputy**

Thomas Schenkel, Head Peter Seidl. **Deputy**

Steve Gourlay, Head Dan Dietderich. **Deputy**

Wim Leemans. Head Eric Esarev.

Deputy

John Corlett. LCLS II F. Sannibale. **APEX**

















Accelerator technology at LBNL is strongly supported by the Engineering Division, a matrixed organization

Engineering Division

K.E. ROBINSON

Division Director & Laboratory Project Management Officer

Magnetics

R.D. SCHLUETER Division Deputy and Department Head Mechanical
R.M. DUARTE
Department Head,
Interim

Mechanical Fabrication & Technology

S.P. VIROSTEK
Department Head

Electronics, Software & Instrumentation

H. VON DER LIPPE Division Deputy and Department Head Operations
J.C. FREEMAN
Division Deputy and
Department Head

Engineering Systems
D. LEITNER
Lead



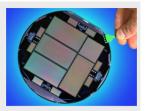
Assembly Shop



Composites Shop



Machine Shop



Microsystems Laboratory



Researcher Shop



Semiconductor Detector Laboratory



Sheet Metal Shop



Technician's Machine Shop



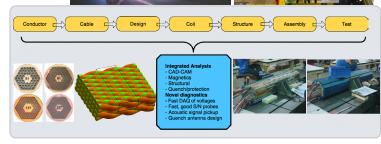


Primary accelerator facilities and capabilities at LBNL span a wealth of technologies

Plasma, ion beam and accelerator technology

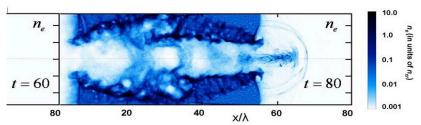
Superconducting magnet technology

Beam Physics technology and expertise





Laser-plasma related technologies and expertise









Plasma, ion beam and accelerator technology: coatings

Plasma Applications Group, (Andre Anders, http://pag.lbl.gov/Facilities)

- Development of advanced techniques for coating and thin film deposition
 - Physical vapor deposition
 - High Power Impulse Magnetron Sputtering
 - Nanoparticle Synthesis by Terminated Cluster Growth
 - Cathodic Arc Deposition
 - Transparent Conducting Oxides (TCOs)
 - Dynamic (switchable) "smart" windows
 - SRF cavities
 - Ion beam analysis (1.7 MV Pelletron)











Plasma, ion beam and accelerator technology: fusion sciences

Fusion Science Group (http://www-afrd.lbl.gov/research_fusion.html)

- NDCX-II (neutralized drift compression experiment)

 intense, pulsed ion beams
 - with peak currents >1 A, 1.2 MeV, ~1 mm^2 spot size, 2 shots/min
 - Extreme chemistry, materials processing far from equilibrium, studies of warm dense matter (~1 eV, ~1 GPa)
 - Radiation effects testing
 - Formation, transport and manipulation of ion beams with very high space charge
 - Research in heavy ion accelerator technology based on MEMS
 - Simulations, design and testing (of selected aspects) of heavy ion beams as drivers for inertial fusion







Plasma, ion beam and accelerator technology: lon sources and beams

Ion Beam technology Group (http://www-afrd.lbl.gov/research_ibt.html)

- Ion source development
 - Penning type, filament, RF, microwave, field ionization, ...
 - Ion source optimization for lifetime, ion species, current density, emittance, ...
- Accelerator front end systems
 - Ion extraction, injection and low energy beam transport
 - Simulations, design, fabrication and testing
- Single ion implantation and qubit materials development in silicon and diamond
 - Ion implantation with scanning probe alignment
- Neutron generator development
 - Optimized for high yield, compactness, or associate particle imaging
 - Neutron irradiation test setup for 10⁸ n/s DD e. g. for detector testing

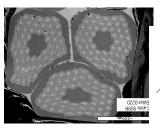


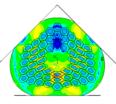


Superconducting magnet technology: Materials

Superconducting materials

- In-depth understanding in materials science and metallurgy associated with superconductors and materials associated with magnet construction;
 - Heat treatment schedules and optimization
 - Materials compatibility
- Nb₃Sn reaction furnaces (up to 4m) and associated heat treatment schedule optimization
- Bi2212 reaction furnace (1Atm O2, up to 1000C);
- 60-strand Rutherford cabling machine, with experience in NbTi, Nb₃Sn, and Bi2212 Rutherford cables;
- Various material characterization capabilities (e.g. SEM)
- Automated tape-insulation system
- Short-sample testing capability
 - Nominally 4,2K, up to 15T
 - Variable temperature, variable strain capability







Reaction sample on new holder



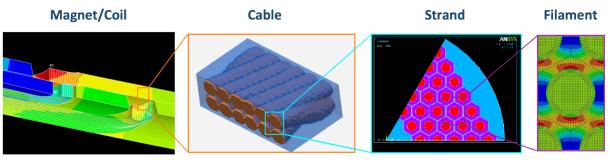




Superconducting magnet technology: magnet design, analysis, and fabrication

Magnet design and analysis

- Expertise in advanced magnetic and structural design of superconducting magnet systems
 - Coupling of beam optics and magnetic design
 - Direct coupling of CAD and 3D FEA
- Design and analysis of passive and/or active quench protection systems
- Field quality analysis and field correction design





- Experience in NbTi, Nb3Sn, Bi2212, and YBCO coil fabrication
- Multiple independent coil winding setups
- Variety of magnet assembly tooling systems
- Experienced with magnet diagnostic instrumentation for R&D magnet systems: voltage taps, strain gauges, etc.











Primary accelerator facilities and capabilities at LBNL span a wealth of technologies

- Superconducting magnet and other cryogenic testing
 - Multiple vertical test cryostats
 - Cryocooler based cryostat (conduction cooling only)
 - Sophisticated quench detection systems and associated electronics to drive active protection circuits
 - Breadth of diagnostic capabilities (128+ channels, up to 500KHz):
 - Acoustic sensors, including spatial localization via triangulation
 - Quench antennas for EM disturbance identification and localization
 - Strain gauge monitoring, with temperature compensation
 - Voltage tap monitoring

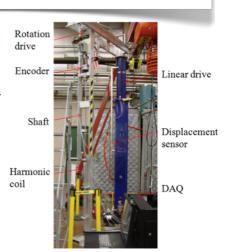


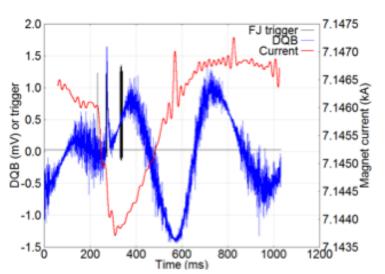


Magnet testing and diagnostics

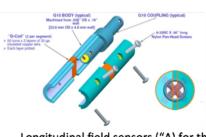
Field quality measurements

High performance and measurement throughput: 24-bit resolution (10-5 of main field amplitude) at 100 kHz sampling rate; expandable to 1000+ channels; with room for further improvement

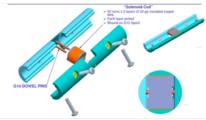




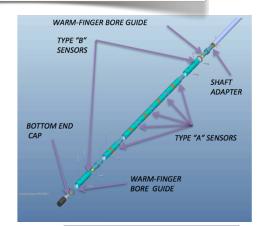
Perturbation sensing

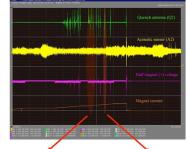


Longitudinal field sensors ("A) for the magnet straight section

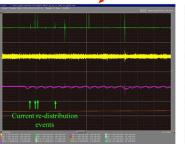


Transverse field sensors ("B") for the magnet ends















Beam Physics technology and expertise: RF and Microwave low-power testing, ion-beam front ends

- RF and microwave low-power test facilities
 - Full characterization of RF and microwave properties of materials up to 50 GHz.

- Ion beam front ends/LEBT:
 - RFQ design, engineering, and fabrication
 - Sophisticated modeling of ion beam source and transport









Beam Physics technology and expertise: High-precision digital control

High precision digital control of mode-locked laser oscillators and RF and microwave systems.

- RF cavity control
 - Normal or superconducting, continuous or pulsed
 - Few millidegree control of RF phase (<10fs at S-band)
 - Full digital control for high stability, complex-valued feedback
- Laser oscillator control
 - Lock free space or fiber femtosecond oscillators to RF, <10fs
 - Lock femtosecond oscillators to optical frequency, <1fs
 - Timing noise measurement and reduction
- Optical transmission of timing signals
 - Sub-femtosecond optical reference distribution
 - Optical phase-locked loops with MHz control bandwidth
 - Atomic line references for absolute optical frequency control



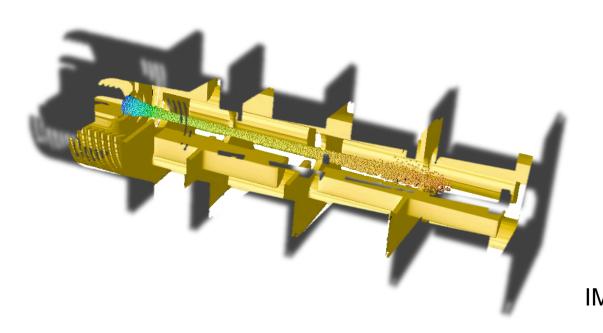




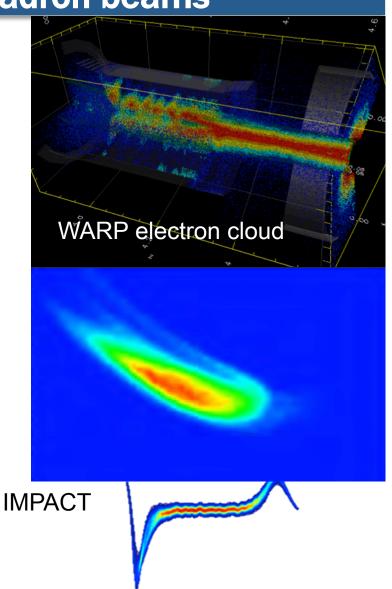


Beam Physics technology and expertise: Modeling of lepton and hadron beams

- Modeling of lepton and hadron beams
 - Beam dynamics
 - Beam-beam interaction
 - Space-charge effects in high-intensity beams
 - Modeling of free-electron lasers



WARP beam dynamics



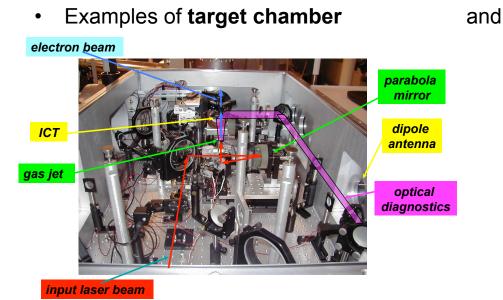




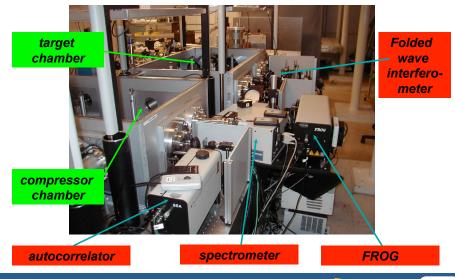


Laser-plasma related technologies and expertise: irradiation testing, excitation of targets

- Irradiation testing of detectors and microelectronic circuits
 - using electron beams produced in a Laser Plasma Accelerator (LPA) with energy from 10s of MeVs to couple of GeVs
- Simultaneous excitation of any targets with high energy electron bunches and ultrashort laser pulses (800 nm, 532 nm and 1064 nm)
 - studying responses with high precision optical diagnostic suites (pump-probe and/or spectroscopy) at ultrafast timescales down to femtoseconds, and at a wide range of wavelengths from THz to X-rays



multiple diagnostics:



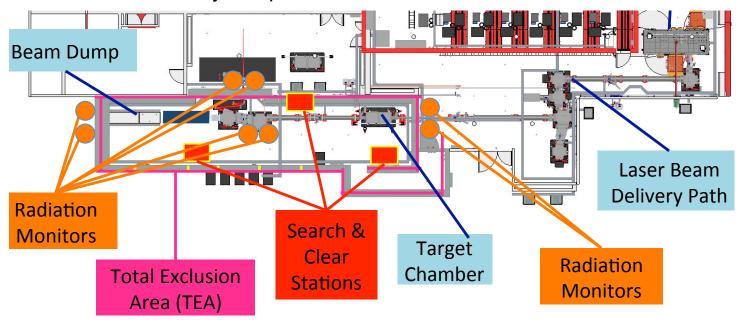






Laser-plasma related technologies and expertise: activation and isotope production

- Activation of medically relevant materials and generation of rare isotopes
 - Capabilities include irradiation with electrons, gammas, or neutrons, and measuring the resulted activation levels and properties (in collaboration with other LBNL Divisions)
 - The BELLA LPA shielding and radiation monitoring systems provide additional diagnostic tools (see layout below)
 - Example system studied before: measurements of ^{99m}Tc production via ¹⁰⁰Mo(γ,n)⁹⁹Mo -> ^{99m}Tc in unexplored energy regimes
- Layout of BELLA labs w/ key components of radiation detection:



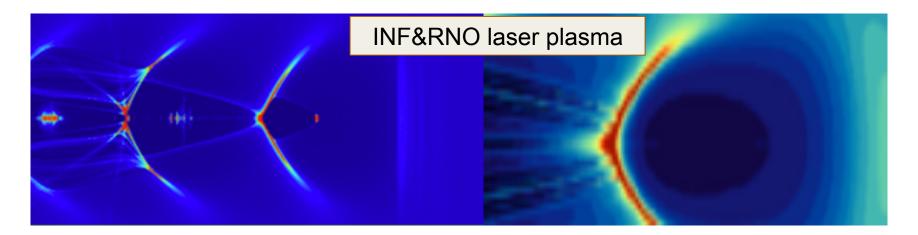


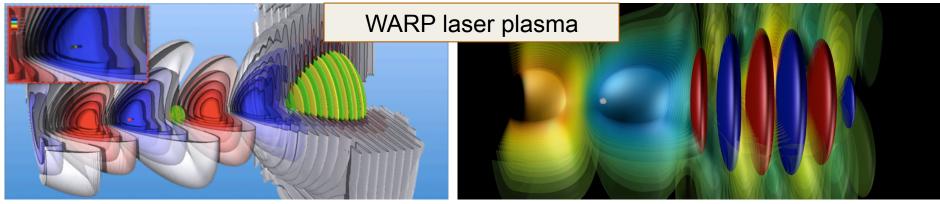




Laser-plasma related technologies and expertise: Modeling of laser-plasma interactions

- State-of-the-art modeling of laser-plasma acceleration
 - Laser-plasma interaction physics
 - Modeling of associated radiation physics: Betatron, Thompson scattering, FELs, etc.











The areas described above are not exhaustive – we have others we welcome you to explore!

- The 88" Cyclotron (http://cyclotron.lbl.gov) is an operating facility providing a broad spectrum of ion beams
- APEX (Advanced Photo-Injector Experiment) is dedicated to the development and test of a new concept high-repetition rate high-brightness electron injector optimized to operate at the performance required by a high-repetition-rate x-ray FEL.
- And more...

Contact us directly to explore additional areas for accelerator technology collaborations

